THE CLAIMS

That which is claimed is:

1. A two-stage reactor for removing pollutants from gaseous streams, the two-stage reactor comprising:

a) an upper thermal reaction chamber comprising:

i) an outer exterior wall;

ii) an interior porous wall, wherein the interior porous wall defines a central combustion chamber, and wherein the interior porous wall is positioned from the outer exterior wall a sufficient distance to define an interior space;

iii) at least one waste gas inlet in fluid communication with the central combustion chamber for introducing a gaseous waste stream therein;

iv) thermal means for combusting the gaseous waste stream, thereby forming reaction products;

v) means for introducing a fluid under pulsing conditions into the interior space, wherein the interior porous wall provides for transference of the fluid from the interior space into the central combustion chamber at a sufficient force to reduce deposition of reaction products on the interior porous wall;

b) a lower reaction chamber comprising:

i) a gas flow chamber in fluid communication with the central combustion chamber comprising an inlet and outlet for passing the gaseous waste stream and reaction products therethrough;

ii) at least one oxidant inlet positioned to introduce an oxidant to the gas stream flow chamber; and

iii) a liquid vortex positioned near the inlet of the gas flow chamber, wherein the liquid vortex comprises means for generating a downwardly flowing liquid film on interior surfaces of the gas stream flow chamber thereby reducing deposition and accumulation of particulate solids thereon.

2. The two-stage reactor according to claim 1, wherein the interior space positioned between the outer exterior wall and the interior porous wall is an interior annular space.

3. The two-stage reactor according to claim 2, wherein the fluid introduced into the interior annular space is pressurized.

4. The two-stage reactor according to claim 1, wherein the fluid under pulsating conditions is selected from water, air, clean dry air, and clean enriched air.

5. The two-stage reactor according to claim 4, wherein the fluid is water.

6. The two-stage reactor according to claim 2, wherein the fluid is injected into the central combustion chamber under periodic pulsing.

7. The two-stage reactor according to claim 1, wherein the pulsing conditions comprises a pulsation duration of from about 20 ms to 100 ms.

8. The two-stage reactor according to claim 1, further comprising at least one additional gas inlet for introducing a combustible fuel or an oxidant for mixing with the gaseous waste stream.

9. The two-stage reactor according to claim 8, wherein the combustible fuel is oxygen, propane, methane or hydrogen.

10. The two-stage reactor according to claim 1, wherein the liquid vortex comprises:

(i) a outer shell having a top plate, a central opening in fluid communication with the central combustion chamber;

a conical-shaped baffle within the outer shell having an inner surface and a central opening which is generally aligned with the interior surface of the gas stream flow chamber, the conical-shaped baffle generally concentrically aligned with the inner surface of the outer shell to form a concentric chamber; and

(ii) a liquid inlet arranged to tangentially introduce liquid into the concentric chamber, thereby filling the concentric chamber with liquid to create a swirling

motion, causing the liquid to rise and overflow the conical-shaped baffle to form a sheet of fluid on the inner surface of the conical-shaped baffle that flows downwardly onto the interior surface of the gas stream flow chamber.

11. The two-stage reactor according to claim 10, wherein the sheet of fluid on the inner surface of the conical-shaped baffle inhibits contact of an entering gas stream with the interior surface of the gas stream flow chamber thereby resisting deposition of reaction products thereon.

12. The two-stage reactor according to claim 1, wherein the interior porous wall is fabricated of a material comprising sintered ceramic, sintered metal, porous metal material or a porous polymeric material.

13. The two-stage reactor according to claim 12, wherein the interior porous wall comprises pores uniformly distributed in the porous material.

14. The two-stage reactor according to claim 1, wherein the outer exterior wall and the interior porous wall are separated a sufficient distance to provide an annular space and for distributing a pressured gas for passage through the interior porous wall.

15. The two-stage reactor according to claim 14, wherein the interior porous wall comprises a plurality of apertures for passage of a pressurized gas through the interior porous wall into the central combustion chamber.

16. The two-stage reactor according to claim 2, wherein the fluid is compressed to a suitable pressure to facilitate pulsating ejection of the fluid with a force sufficient to reduce particle deposition on the inner surface of the central combustion chamber.

17. The two-stage reactor according to claim 16, wherein the pressure is from about 60 psig to about 100 psig.

18. The two-stage reactor according to claim 15, wherein the plurality of apertures comprises conical shaped protuberances.

19. An abatement system for controlled combustion of gaseous pollutants in a gaseous waste stream, the system comprising:

a) an upper thermal reaction chamber comprising:

i) an outer exterior wall;

ii) an interior porous wall, wherein the interior porous wall defines a central combustion chamber and wherein the interior porous wall is positioned from the outer exterior wall a sufficient distance to define an interior annular space;

iii) means for introducing a fluid in a pulsating mode to the interior annular space;

vi) thermal means for combusting the gaseous waste stream, thereby forming reaction products;

v) at least one waste gas inlet for conducting the gaseous waste stream into the upper thermal reactor, the waste gas inlet comprising a conduit terminating with a portion of the conduit within the central combustion chamber wherein the portion of the conduit is located within a tube which projects beyond the end of the conduit to define a chamber within the tube for flame formation, the tube having an open end communicating with the central combustion chamber;

b) a lower reaction chamber comprising:

i) a gas flow chamber in fluid communication with the central combustion chamber;

ii) at least one oxidant inlet positioned to introduce an oxidant to the gas stream flow chamber; and

iii) a liquid vortex positioned between the central combustion chamber and the gas stream flow chamber, wherein the liquid vortex comprises:

(1) a outer shell having a top plate, a central opening in fluid communication with the central combustion chamber;

(2) a conical-shaped baffle within the outer shell having an inner surface and a central opening which is generally aligned with the interior surface of the gas stream flow chamber, the conical-shaped baffle generally concentrically

aligned with the inner surface of the outer shell to form a concentric chamber; and

(3) a liquid inlet arranged to tangentially introduce liquid into the concentric chamber, thereby filling the concentric chamber with liquid to create a swirling motion, causing the liquid to rise and overflow the conical-shaped baffle into the gas stream flow chamber to form a sheet of fluid on the inner surface of the conical-shaped baffle that flows downwardly onto the interior surface of the gas stream flow chamber.

20. The abatement system of claim 19, wherein the interior porous wall provides for transference of the fluid from the interior annular space into the central combustion chamber at a sufficient force to reduce deposition of reaction products on the interior porous wall;

21. The abatement system according to claim 19, wherein the interior porous wall comprises a porosity of from about 30 % to about 80%.

22. The abatement system according to claim 19, wherein the fluid introduced into the annular space is pressurized.

23. The abatement system according to claim 19, wherein the fluid is selected from water, air, clean dry air, and clean enriched air.

24. The abatement system according to claim 19, wherein the fluid is water.

25. The abatement system according to claim 20, wherein the fluid injected into the central combustion chamber through the interior porous wall comprises steam.

26. The abatement system according to claim 19, further comprising at least one additional gas inlet for introducing a combustible fuel or an oxidant.

27. The abatement system according to claim 26, wherein the combustible fuel is oxygen, propane, methane or hydrogen.

28. A method for controlled combustion of gaseous pollutants in a gaseous waste steam in a two-stage thermal reactor, the method comprising:

i) introducing the gaseous waste stream to an upper thermal reactor through at least one waste gas inlet;

ii) providing at least one combustible fuel for mixing with the gaseous waste stream to form a fuel rich combustible gas stream mixture;

iii) igniting the fuel rich combustible gas stream mixture in a combustion chamber to effect formation of reaction products;

iv) injecting an additional fluid into the combustion chamber contemporaneously with the combusting of the fuel rich combustible gas stream mixture, wherein the additional fluid is injected in a pulsating mode and in a circumventive pattern within the combustion chamber and at a force exceeding that of the reaction products approaching the interior surface of the combustion chamber thereby inhibiting deposition of the reaction products thereon;

v) flowing the stream of reaction products into a lower reaction chamber while introducing into the stream of reaction products an air-containing gas thereby providing a fuel lean mixture; and

vi) flowing the stream of reaction products through a water vortex positioned near the entrance of the lower reaction chamber, wherein water falling from the water vortex inhibits deposition of the reaction products on the interior surface of the lower reaction chamber.